

## **Resource Potential of the Tana Basin with Particular Focus on the Bwathonaro Watershed, Kenya**

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### **Abstract**

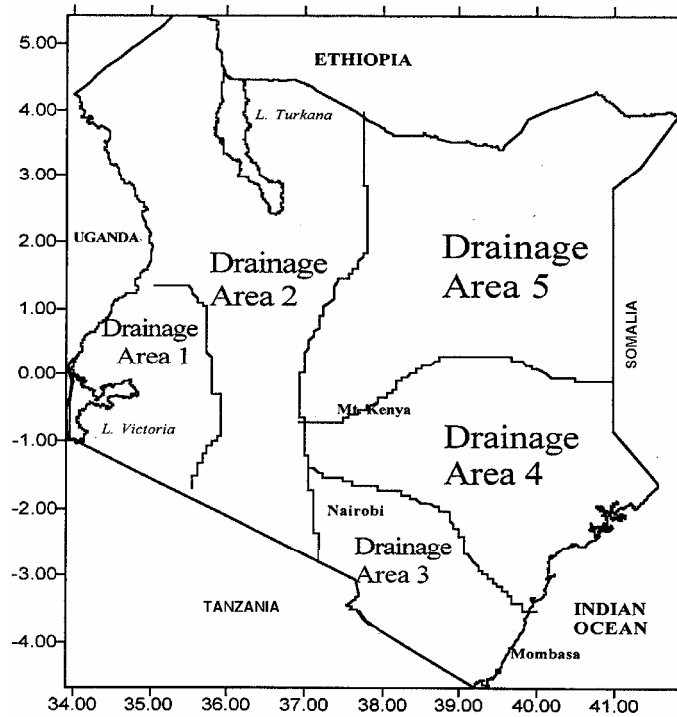
The Tana Basin of Kenya is one of the most important basins in the country comprising of several catchments that are endowed with diverse resources. The utilization of these resources is necessary to the development of the basin and the whole country. However, the way the various resources in the basin are used can have serious implications on the basin's environment upon which the resources depend. Before resources in any basin can be put to use, it necessary and important to know the type of resources available in the basin and how use of the resources affects the basin or catchment. In this paper a general overview of the Tana Basin is provided and the resource potential in the Bwathonaro watershed, an important catchment in Meru North District in the upper parts of the basin, presented. The challenges of resource utilization in the watershed are examined and some of the interventions to the challenges suggested towards ensuring integrated and sustainable management of the resources in the watershed for continued development of the watershed and the entire basin.

### **Introduction**

The Tana Basin shown as drainage Area 4 in Figure 1.1 is one of the five drainage basins in Kenya covering nearly 21% of the country's total surface area and covers various agro-ecological zones. It has three major water towers namely Mt. Kenya

in the North and North East contributing about 49% of runoff, the Aberdare Ranges to the West contributing about 42% and the Nyambene Hills to the East of the basin contributing nearly 7% of the total runoff in the basin (WRMA, 2006). The Tana is the main River traversing the basin and has many tributaries bringing water to it. The basin enjoins twenty districts in four different provinces namely Central, Eastern, North Eastern and Coast. It sustains a population of about five million people.

The river has a total length of about 1,012 kilometers from the farthest source to the Indian Ocean and has an annual mean discharge of five billion cubic meters covering a total catchment area of about 126,000 km<sup>2</sup>. It is divided into three catchments namely upper, middle and lower catchment areas. The upper catchment covers about 15,000 km<sup>2</sup> at an altitude of 1000 m above mean sea level whilst the middle catchment covers an area of 15,700 km<sup>2</sup> at an altitude of between 1,000 and 200 meters above mean sea level. The lower catchment covers about 95,300 km<sup>2</sup> at altitudes below 200 meters (Hirji et al., 1996).



**Figure 1.1:** The drainage basins of Kenya with the Tana Basin indicated as drainage Area 4 (Source: NEMA, 2003)

Since the basin traverses various regions of diverse agro-ecological zones, its agricultural potential and production varies from one catchment to another with the upper portions of the basin having the largest concentration of coffee and tea farms. Horticultural crops and flowers, rice and food crops such as cereals, bananas and potatoes are also produced in various parts of the basin. Livestock production is also practiced for milk, beef and mutton while pig farming in the basin is widespread (Hirji et al., 1996; Agwata, 2005b). Nearly 70% of the hydroelectricity supply in the country is generated from the several dams located in the basin. This

hydropower potential is due to the many tributaries scattered in parts of the upper portion of the basin with a hydropower potential estimated at 960 MW. Currently, six dams are located at various points along the main Tana River.

Other economic activities within the basin include wildlife in the forests on the mountains in the upper parts of the basin that serve as important wildlife conservation sites with several game parks and tourism destination centers. The lower parts serve as rich habitats for biodiversity which is important for development of tourism activities in the basin. Since nearly 80% of the basin is arid and semi arid and only 20% of the land is humid where rain fed agricultural production is practiced, some form of supplemental water in order for any meaningful socioeconomic activities to take place, increasing of both human and livestock population puts increasing demand for various resources such as energy, food and pasture in most parts of the basin (WRMA, 2005).

The agro-ecological zones in the basin are high potential zones in which coffee, tea, pyrethrum, wheat and barley; dairy, sheep and poultry are practiced whilst the medium potential zone maize, sunflower and beans as the major crops although some poultry, sheep and dairy are also kept. The low potential zone has millet, cotton, tobacco and sorghum as the main crops. The irrigation potential in the basin is estimated at 132,000 hectares with the developed and planned irrigation schemes covering an area of 54,676 ha. The irrigation practices found within the basin fall under three categories namely small scale group based schemes dealing mainly with horticulture and floriculture; individual holder schemes mainly for high cost crops such as macadamia, floriculture and ornamental crops and the public irrigation schemes that are managed by government agencies such as the National Irrigation Board and the Agricultural Development Corporation.

The increasing population, expansion in industrial and commercial activities and changes in land use practices in the basin has resulted in increasing demand for various resources. For instance, increased demand for water resources causes conflicts in water utilization due to competing interests. Utilization of the water resources should be done such that conflicts arising out of resource use are

minimal and are resolved amicably to reduce tensions that are likely to affect the development of the basin and associated catchments. The major challenges affecting the basin include over abstraction of water, poor water resources management, pollution and basin degradation. To address some of these challenges, various resources in the basin such as soils, forests, energy, wildlife, minerals and water should be conserved to ensure continued availability for various competing uses. All the stakeholders should also be encouraged to actively participate in the management of the resources in the basin (Agwata, 2005a, b).

### **The Bwathonaro Watershed**

The Bwathonaro watershed is a small catchment covering about 150 km<sup>2</sup> located in Meru North District in the Eastern Province of Kenya. It lies between approximately 2,050 m above sea level in the upper sections and about 700 m above sea level in the lower parts near the Meru National Park. On average, annual rainfall in the catchment is ranging between 700 and 1300 mm per year and is bimodally distributed in two seasons namely the long rainy season from March to May and the short rainy season from October through December. The average annual temperature over the catchment is about 18° C.

The population density in the catchment is about 350 persons per km<sup>2</sup> with a total population of about 46,000 people. About 45 water projects are operating in the catchment with only fourteen having permits while the rest operate illegally. The catchment has rich agricultural potential with both food and cash crops grown in the area. The main cash crops include tea, coffee and miraa while the food crops include maize, beans, sugarcane, and arrow roots. Many farmers plant trees such as eucalyptus, gravellier next to the watercourses besides tilling the land near the edges of the water. This leads to serious erosion in the catchment and siltation of the River (WRMA, 2005, 206).

## **Resource Potential in the Watershed**

The Bwathonaro watershed is endowed with various resources whose utilization can have a positive or negative impact on the watershed. To appreciate the implications of resource use in the watershed it is necessary to know what resources are available in the watershed since the planning and management of the resources significantly influences the social and economic development of the watershed and the entire basin. On the other hand resource utilization in the watershed can have implications on the adjacent watersheds and the entire basin especially if there are some cases where certain areas are facing deficits in specific resources due to natural or anthropogenic reasons.

The natural conditions in the Bwathonaro River watershed are influenced mainly by the Nyambene hills which due to variations in altitude influence the environmental conditions resulting in a wide variety of microclimates and agro-ecological zones. The upper parts of the watershed are forested and provide important catchments for the various resources such as water which is necessary for commercial, domestic, irrigation and wildlife in the watershed. The watershed and the district are endowed with diverse resources that have greatly contributed to the socio-economic development of the area. Some of these resources include water, land/soil, energy, forestry and wildlife.

In the following sections available resources in the watershed such as human, water, land/soil, forests/wildlife and energy resources are presented.

### **(a) Human Resource**

Bwathonaro watershed cuts across several divisions in Meru North District including Igembe East, Central, North and South East; Ndoileli and Meru National Park. The various divisions that form the watershed vary in area, population sizes and densities. The total population is estimated at 46,000 people with a density of 350 persons/ km<sup>2</sup>. The divisions in the drier zones to the north of the watershed have lesser population density.

High levels of absolute poverty occur in some parts of the watershed with urban slum dwellers located in towns and market centres in the watershed. Due to this, cases of child labourers are found in khat growing parts of the watershed. This has seriously affected enrolment levels particularly for boys in the primary schools. Due to high population densities in the high potential areas, people have moved to less populated areas, forested areas, steep hills, swamps, river banks causing serious destabilization of the watershed ecosystem. This has caused serious cases of environmental degradation in the watershed and affected other resources such as water, land and soils and forests.

#### **(b) Water Resources**

The watershed is not well endowed with surface water resources especially in the arid and semi arid zones of the area. The main water source in the area is River Bwathonaro whose water is abstracted for various activities in the watershed. The water from the river serves the people in the upper, middle and lower zones of the watershed. The water is heavily abstracted from the river at various points and sold to various users at KShs 70 per a 20 l jerry can.

About forty five water projects operate in the watershed although only fourteen are licensed with the rest operating illegally. Other sources of water that have potential include several springs most of which are not protected. Several swamps such as Mporoko also exist in the watershed but have been encroached into and degraded causing reduction of water into the river. Due to the degradation of the swamps, the quality of the water in the springs and river has been affected although the exact extent and nature of the pollution in terms of loadings and characteristics are not known.

Information on the status of ground water resources in the watershed that can be used to supplement surface water sources is generally not available.

#### **(c) Land and Soil Resources**

The watershed has land and soils that are useful for various agricultural activities. Since most of the land in the watershed is trust government land, cases of encroachment are high and the local administration has been involved in the past in

the subdivision and settlement of people in government land causing serious degradation of the watershed. The subdivision of land to small parcels has reduced economic viability of the land for various economic activities.

There is urgent need to move people from water catchment areas like swamps and springs and have them resettled elsewhere. Concerted soil and land conservation efforts and extension services to increase agricultural productivity of the land should also be encouraged.

The watershed has good soils which are of volcanic origin and highly productive. The land and soils are suitable for various agricultural crops such as tea, coffee, khat, macadamia, bananas, arrow roots and various tree species such as blue gum, eucalyptus and pine. Due to the nature of the soils, the area has rich agricultural potential since the soil is rich in various nutrients. The trees and crops planted next to water courses and river line systems cause serious erosion in the watershed and siltation of River Bwathonaro which affects its quality.

#### **(d) Forests and Wildlife**

The watershed has Nyambene hills as the main forest. Portions of Meru forest are also in the watershed and serves as an important water catchment area. The forests have been affected through cutting of trees for settlement and various products and materials such as fuel wood, charcoal, wood products, fruits, vegetables, medicines and construction materials. The destruction of the forest cover and clearance of vegetation have affected the recharge rates of the springs and increased surface runoff causing serious soil erosion and siltation in the watershed. The agricultural productivity of the watershed is also likely to be affected if the rates of forest clearance in the watershed are not checked.

The Meru National Park with an area of 878.2 km<sup>2</sup> had a human population of 443 people in 2002 but his would have increased by now due to illegal excision of the forest and encroachment due to human settlements. This is likely to affect the socio-economic status of the watershed since the Park serves as an important habitat for biodiversity which is a source of revenue for the watershed through tourism activities.



The encroachment and destruction of the forest also has far reaching consequences on water resource which is in great demand in the watershed.

#### **(e) Energy Resources**

River Bwathonaro is one of the tributaries of the Tana River which supplies water to the several dams in the basin for hydropower generation. The river can also serve as a source of water for small dams to store water for use in the production of micro-hydropower in the watershed. There is potential for solar and wind energy production in the arid and semi arid parts of the watershed but this needs to be examined.

The possibility of biogas production as a source of energy using human and agricultural wastes is another way to reduce pressure on forests and other resources used as energy sources in the watershed.

#### **Challenges of Resource Use in the Watershed**

Utilization of various resources in the watershed has various implications and challenges that need to be addressed to ensure sustainable and integrated use of the resources. The major challenge in the watershed is resource degradation and scarcity. For instance, water scarcity is a major issue in the watershed due to increasing demand for competing uses such as irrigation, domestic and commercial activities. In the watershed, there is increasing need for water for irrigation of khat farms and other land use activities. This often leads to over abstraction of the water from the main river in the watershed particularly in the dry season when there is usually stiff competition for water among the various projects that require water. In some cases some of the khat and eucalyptus farmers can abstract the water leaving the river without any flow downstream. During the dry season, there is serious water shortage in the watershed, which affects all categories of water users such as the domestic, water vendors, residents in trading centers, those needing water for irrigation, road construction, various farming activities and wildlife needs within the area.

The various land use activities in the watershed require water for their operations and since there is lack of sufficient quantities to satisfy all needs, there are serious conflicts due to different water demands in the watershed. The first conflict due to water scarcity and distribution is caused by the uneven spatial and temporal distribution of water in the watershed which is aggravated by the fact that a large percentage of the watershed is in arid and semi arid zone. This means that water demands in these dry zones have to be met from areas with abundance and the excess stored during the wet season for use in the dry season. Also, consumptive uses such as irrigation are known to remove water from the watershed that would otherwise be used for other functions.

The other challenge is deforestation and vegetation clearance of wetlands, springs and swamps by way of cutting of indigenous trees in the catchment for settlements, agriculture and commercial activities. The drainage of wetlands like the Mporoko swamp, which is the main source of river Bwathonaro, is due to the need for cultivation of arrow roots and yams (WRMA, 2005, 2006). The watershed also faces serious environmental degradation due to wanton destruction of swamps, springs and planting of tree species that use lots of water, encroachment of river banks and planting of non water friendly trees near the river banks. The river can easily dry up especially during drought conditions as a result of over abstraction and the changes to the river course, leading to biodiversity loss in the river. The degradation of the environment on which various resources depend may occur due to poor land use activities leading into intensification in the demand for resources within the watershed.

Another challenge is due to lack of sanitation and sewerage facilities especially in urban centres and towns. This means that sewage and other pollutants from commercial activities and agricultural produce such as coffee, tea, tobacco processing and insecticides, herbicides and fertilizer use that produce effluents and residues find their way into the Bwathonaro River and other streams causing water pollution. The generation of domestic and sewage wastes also degrades the quality of water in the rivers if these are not properly treated and disposed of. As a result

of the poor quality of the water from the river and the streams, the water is unusable for other purposes unless it is treated. The river and streams in the watershed also receive lots of sediments and silt from erosion processes in the watershed. The accumulation of the sediments and silt in the river courses and streams reduces the amount of water available for various functions.

### **Interventions on Resource Use**

#### *Regulation in the Use of the Watershed's Resources*

The resources in the watershed should be managed in a sustainable and integrated way by promoting their conservation and by protecting various areas across the watershed. Besides helping to minimize the conflicts over resource use, conservation measures will increase the availability of the resources in the watershed for continued development of the area. In the case of water, water permits should be issued and used in an organized manner so that there is water available to all people at any given time to avoid conflicts among the various water users. Measures that may be applied to avoid or minimize would include construction of water storage facilities like dams and harvesting of water from roofs and surface runoff, gazetting of the key water towers, springs and swamps in the watershed, making laws to govern rivers, acting on illegal connections and revocation of single permit users (Liniger, 1995; WRMA, 2005, 2006). There is need to ensure comprehensive planning to ensure that water diversion upstream is managed in an integrated manner.

To avoid some of the cases of environmental degradation in the catchment, there is need to plant trees that do not consume lots of water, avoid farming along the river line, setting up or rehabilitating the catchment rehabilitation projects and mobilizing funds from all the stakeholders to rehabilitate the catchment area (MFP, 2002).

### Control of Watershed Soil Erosion and Degradation

Soil erosion control measures and mechanisms should be put in place in the watershed so that various land use practices such as agriculture, livestock husbandry, forest resource utilization, settlements and infrastructure development are carried out in a sustainable manner. Farmers and other stakeholders should be encouraged to protect soils from erosion processes through provision of tree seedlings to reduce destruction of forests and vegetation in the river catchment areas. The protection of riverbanks to minimize changes in river line channels should also be made an integral part of agricultural and other land use practices in the watershed. In the case of destruction and encroachment of swamps and springs, there is need to convert catchment areas into public utility places and promote indigenous tree planting activities to conserve the watershed. The available springs in the watershed should also be clearly demarcated and their conservation promoted.

Other mitigation measures that may be applied to minimize the conflicts in resource utilization include formation of joint committees for all the water users in the watershed, giving responsibility of issuance and supervision of water permits to registered water projects under the water user association, involving the government in building capacity for the community living within the watershed, training the selected committee on how to manage water and resolve conflicts, rationing of water according to its availability and ensuring that those next to the water courses allow easy access to the water users.

### Control of Watershed Pollution

Water resources management in watershed and other catchments of the basin should include the protection of water resources from pollution arising from domestic, agricultural, commercial and industrial effluents. The location of various domestic facilities such as pit latrines, abattoirs, coffee factories and other polluting enterprises near water sources need to be discouraged and monitored to avoid heavy pollution loads in the water courses. This can only work if statutory powers to enforce effluent release standards are given to watershed user

associations to carry out all aspects of pollution control such as river monitoring and water pollution surveillance, among others. This requires training of personnel from the associations and the building of capacity to undertake such activities.

#### *Funding for Resources Management*

There is need to address the issue of funding to ensure sustainable use of resources and their management in the watershed. This is vital since resource availability sustains the social and economic development of the people in the watershed. For instance, since water plays an important role in agricultural development, industrial production and commerce, it must be paid for appropriately. The payment for water services provision should meet the costs of water conservation, river regulation, infrastructure maintenance and development, pollution control enforcement and acquisition of necessary data (Al-Mohannadi, et al., 2003).

### **Recommendations**

Continued increase in population puts increasing demand for various resources to meet various needs in the Tana Basin and the Bwathonaro watershed. The various resources in the basin should therefore be managed in a sustainable and integrated way since the social and economic development of the watershed and the basin depends on the availability of the resources in the basin. For this to happen, it is necessary to:

- a. Evaluate the roles of various government agencies and other stakeholders to ensure full benefits and responsibilities of integrated resources management in the watershed and the basin
- b. Built the necessary capacity in the local communities to meet the needs of integrated resources management in their respective areas
- c. Conduct environmental impact assessment of existing and proposed development projects that are likely to negatively impact on the environment upon which all resources depend

- d. Promote multi- and inter-disciplinary approaches to planning, research, implementation and monitoring of resource use practices within the basin and catchment
- e. Identify needs and potentials for education programs for the people at all levels people in various catchment areas to inculcate the proper attitude towards resource use
- f. Develop a watershed management plan to guide the use of various resources in the watershed
- g. Encourage active participation of the local people in the management of watershed resources to ensure sustainable use of the same

### **Conclusion**

The Tana Basin generally and the Bwathonaro watershed in particular are endowed with diverse resources such as water, land/soils, forestry and wildlife. The use of these resources poses serious challenges in the leading to serious conflicts. It is important that resource exploitation occurs in such away to avoid the degradation of the watershed and the basin to ensure continued socio-economic development of the people. This requires the participation of all the stakeholders in coming up with appropriate strategies and mechanisms of ensuring integrated resource use through suitable resource use plans.

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